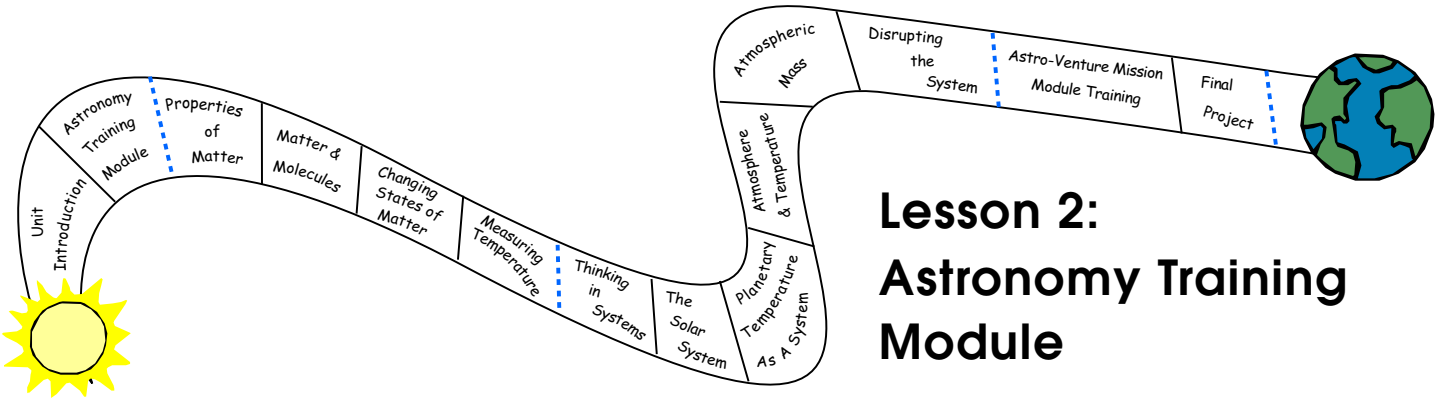


Lesson 2: Astronomy Training Module

Students are introduced to the basic requirements for human survival. Using an online, multimedia module, they change factors of our Solar System and draw conclusions about which factors are necessary for human survival.

Main Lesson Concept: Certain astronomical conditions help to support human survival.

Scientific Question: What astronomical conditions are required for human survival?

Objectives	Standards
Students make changes to our solar system and write descriptive, un-biased observations of the effects of these changes on Earth.	**Meets**: NSES: A 5-8 #1 ISTE 3, 5 **Addresses**: 2061: 4B 6-8 #2 2061: 4A 6-8 #1 NSES: D 5-8 #3
Students will identify the characteristics of our solar system that are required to allow for human survival.	

Assessment	Write-up in Astro Journal.
Abstract of Lesson	Students predict how human survival requirements are met by characteristics of our solar system and planet. They engage in an online Astronomy Training module in which they make changes to the astronomical conditions of our solar system and observe the effects of these changes on Earth. They then draw conclusions about which astronomical conditions are necessary to support human survival.

Prerequisite Concepts	Major Concepts

• Humans need water, oxygen, food, gravity, a moderate temperature and protection from poisonous gases and high levels of radiation to survive. (Lesson 1)
• The Earth is one of several planets that orbit the Sun. Jupiter is a very large planet approximately ten times the diameter of Earth.
• Scientific observations are detailed descriptions of what can be learned using the senses and scientific instruments. These scientific observations do not include ideas, opinions or speculations about what is being observed.
• A star is a large, hot ball of gases, which gives off its own light.
• A planet is a body that does not give off its own light and is orbiting a star. A planet is generally much smaller than a star and can be made of solid, liquid and/or gas.
• A cause is something that produces an effect or result.
• An astronomical unit (AU) is the average distance from Earth to the Sun, which is equal to 149,598,770 km or 93,000,000 miles.
	• The following characteristics allow Earth to remain habitable to humans:
	  • A yellow star
	  • Jupiter in a circular orbit beyond three astronomical units (AU).
	  • An Earth-size planet of a mass that is between one-fourth and four times Earth's mass
	  • The orbit of the Earth-size planet is in the Habitable Zone.
	• Maintaining liquid water on Earth at all times is essential to support human life.

MISCONCEPTION: A common misconception that students have is that the Sun is not a star but is a planet or other object. To help to address this misconception, ask students what the Sun would look like if it were very far away. Ask them what the North Star or other stars would look like, if we were very close to them. Ask students what the differences are between a planet and star. Ask them what kind of object the Sun is. Help them to see that because the Sun is a ball of gases, it is in fact a star, but it doesn't look like other stars, because it is very close to us, while other stars are very far away. In fact, the closest star would take us thousands of years to reach if we were travelling in the fastest rocket.

Note to Teacher: Star types, orbits, planet mass and the Habitable Zone are concepts that are all explored and defined in later lessons. In this lesson, students simply need to make good observations about "what" is needed for human survival. Lessons 3-12 will give them the "whys" behind these needs.

Suggested Timeline (45-minute periods):

Day 1: Engage and Explore Part 1 Sections
Day 2: Explore Part 2 Section
Day 3: Explain, Extend/Apply and Evaluate Sections

Materials and Equipment:

- A class set of Astro Journals Lesson 2: Astronomy Training Module *
- 1 Planetary Comparison Chart for each group
- Astronomy Training Walkthrough (Optional)
- Overhead transparencies of Astronomy Training Screen Shots (Optional).
- 1-30 computers with Internet browser, Internet connection and the Shockwave/Flash Player installed.
- A printer connected to the computers.
- Chart Paper
- Overhead projector
- Headphones for the computers (Optional).

Preparation:

- Prepare class sets of Astro Journals.
- Prepare overhead transparencies of Astronomy Training Screen Shots.
- Make copies of Planetary Comparison Charts for each group.
- Download and install Shockwave/Flash Players on computers. Test these at http://astroventure.arc.nasa.gov by clicking "Astronomy Training."
- Prepare chart paper with major concept of the lesson to post at the end of the lesson.

*Note to Teacher: A generic Astro Journal and Scientific Rubric are included at the end of this part. If you prefer, you can have students use the generic Astro Journal instead of the ones designed to go with each lesson. This might be especially useful for older students who are already familiar with the inquiry method.

Differentiation:

Accommodations

- Pair advanced students with students that may need more guidance.
- Encourage students to talk about what they are learning.

Advanced Extensions

Research and report on whether the moon is a necessary astronomical condition for life and why or why not.

Engage (approximately 10 minutes)

1. Review Lesson 1.

- Question: As members of the Astro-Venture Academy, what is our goal?
- *Answer:* Our goal is to find, study and design planets that would be habitable to humans.

- Question: In the first lesson, what elements did you learn are necessary for human survival?
- *Answer:* The elements humans need for survival are: food, gravity, oxygen, water, a moderate temperature and protection from poisonous gases and high levels of radiation.

2. Introduce the purpose of the lesson.

- Say: Since we know that these elements are necessary for our survival, and our goal is to find and design a habitable planet, then we need to determine which conditions of our star system and planet are most likely to have the elements needed for human survival.

3. Bridge to this lesson.

- Question: When you look at the other planets in our Solar System, which of the necessary elements are most planets missing?
- *Answer:* Most planets do not have oxygen or liquid water, and most have temperatures that are far too extreme for humans.

- Question: Why do you think the other planets do not have these elements?
- *Answer:* (Accept all answers)

4. Present the Scientific Question for this lesson.

- What astronomical conditions allow for human survival?
- Tell students that they will be role-playing scientists and using a computer activity to find out which astronomical conditions humans need to survive and why.

Explore Part 1 - (approximately 30 minutes)

1. Help students identify possible astronomical conditions for human survival.

- Say: In the Astronomy section of Astro-Venture, we will be focusing on the star (like our Sun) and the planets and how these parts of our Solar System interact to give us the conditions we need to survive. We will call these conditions the astronomical conditions.

- Question: What do you think are some of the characteristics of our Solar System that allow Earth to be habitable to humans?
- *Answer:* (Accept all answers. Record these ideas on the board.)

- Have students place a star by the appropriate answers that are astronomical conditions as opposed to conditions related to geology, atmospheric sciences or biology. (These might include orbital shape and distance, star type, the mass of planetary bodies, location of a star in its galaxy, types of objects in the Solar System, the presence of moons).
- Tell students that we will focus on conditions that have to do with planetary and atmospheric composition and the flow of matter and energy in other sections of Astro-Venture.

2. Have students record their predictions in the Prediction section of their Astro Journal of the astronomical conditions that they predict are necessary for human habitation on a planet.

3. Introduce students to the Astro-Venture Astronomy Training Module.

- Tell students that they will be engaging in an online activity where they will change aspects of the astronomical conditions of our Solar System and will observe the effects on Earth. They will then draw conclusions about the astronomical conditions needed for human survival.

- Tell students that as they go through this module, they will be Astro-Venture Junior Astronomers, and will be evaluated on how detailed their observations are, and whether they give reasons for the effects they observe. They will be able to use their notes on the Astro Challenge, so they should take thorough notes.

- You may want to model for students an example of a "good observation." Either project from a computer for the class to see or project the Astronomy Training Screen Shots to walk the students through the following. (You will need to click through the introduction to get to this part).

- Click "Star Type."

- Click "Yellow Star."

- Click "Play" to see the effect on Earth.

- Ask students to describe what happened to Earth and why. Record a good example of the kinds of observations you expect from students such as: "The Earth remained habitable."

- Click "Enter" to see another scientist's observation. Stress to students that they do not need to type the exact same thing, but should have the same general idea.
  Note to Teacher: Students can change their answer after they click "Enter." However, their original answers will be printed in their Astro Journal so that you can see if they are making good, initial observations.

- Point out to students that when they have completed an observation, the factor, which they have chosen turns purple. They must complete all observations in all four major sections before they can advance to the Astro Challenge section.

- Click "Red Star."

- Click "Play."

- Ask students to give a detailed observation such as: "The Earth would grow cold and would be covered with ice and snow, because the Red Star is too cold."

Explore Part 2 - (approximately 45 minutes)

1. **Have students engage in the Astronomy Training Module individually, in pairs, small groups or as a class.**

- Students should visit: http://astroventure.arc.nasa.gov and click "Astronomy Training."
  Note to Teacher: You will need the Shockwave/Flash Player plug-in, which can be downloaded and installed from http://sdc.shockwave.com/shockwave/download/ When tested with grades 5-8, the average completion time for 5th graders was 45 minutes. For 8th graders it was 30 minutes. Also, you will want to have accessibility to a printer, so students can print their Astro Journals at the end of the module. These can be used for evaluation purposes. If you want to take the whole class through the module using one computer, use the Walkthrough as a guide.

Explain (approximately 15 minutes)

1. **Have students fill out the Results and Conclusion section of their Astro Journals.**

2. **Discuss students' Conclusions.**

- Question: What astronomical conditions did you observe are necessary for human habitation of a planet?
- *Answer:* (Record on the board) We need: a yellow star, any Jupiter-size planets in a circular orbit beyond 3 AU, a planet with a mass that is 1/4-4 times the mass of Earth that is orbiting in the Habitable Zone.

- Question: Why do we need each of these? What happens to the planet otherwise?
- *Answer:* (Record the reasons next to each factor)

Astronomical Condition	Reason
A yellow star	To maintain a temperature that is neither too hot nor too cold for liquid water.
Jupiter-size planet in a circular orbit beyond 3 AU	To prevent any Earth-size planets from being thrown out of their orbit to freeze.
A planet with a mass between 1/4 and 4 times Earth' s mass	To maintain a temperature that is neither too hot nor too cold for liquid water.
The Earth-size planet must orbit in the Habitable Zone.	To maintain a temperature that is neither too hot nor too cold for liquid water.

- Question: What is the common theme of all of these conditions?
- *Answer:* They allow for liquid water to be present on a planet.

Extend/Apply (approximately 15 minutes)

1. **Have students apply these astronomical conditions to another planet in our Solar System.**

- Have students choose another planet in our Solar System, and use the Planetary Comparison Chart to describe what astronomical conditions would need to change in order for the selected planet to be habitable. They should record this information in the Creating Habitable Conditions for Other Planets section of their Astro Journals.

Evaluate (approximately 15 minutes)

1. **As a class, have students share their planet and discuss what astronomical changes would be necessary to make it habitable to humans.**
   Based on what students know so far, their assessments should include observations that most planets are not in the Habitable Zone or have a mass that is too large or small.

2. **Tell students that in the next section they will begin to explore the conditions required for water to be a liquid and to clarify how these conditions help us to maintain this essential element for human survival.**

3. **Collect Astro Journals and evaluate using the Scientific Inquiry Evaluation Rubric to make sure students are ready for the next lesson.**
   In particular, assess students' scientific observations for detail, accuracy, and inclusion of a reason and absence of bias.

Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the 'conceptual flow' and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding. For this lesson, the chart of astronomical conditions needed for human survival on a planet and why these conditions are necessary should also be posted.

Astro Journal Lesson 2: Astronomy Training Module

Name:

Class/Period:

Date:

1. Scientific Question:

What astronomical conditions allow for human survival?

2. Hypothesis/Prediction: What astronomical conditions do you think humans need to survive? Why?

3. Materials: What source will you use to gather data that will help answer this question?

4. Data: The following may be recorded and printed online. However, if you are unable to print from the computer, you may use the following chart to record your observations.

Cause	Effect on Earth
Blue star	
Yellow star	
Red giant	
Red dwarf	
Jupiter in a cirular orbit beyond 3AU	
Jupiter in an elliptical orbit at 1 AU	
Small Earth (less than 1/4 mass)	
Average Earth (1/4 to 4 times mass)	
Large Earth (more than 4 times mass)	
Short of the Habitable Zone	
In the Habitable Zone	
Beyond the Habitable Zone	
Earth in an elliptical orbit	

Astro Journal Lesson 2: Astronomy Training Module

Class/Period:

Name:

Date:

5. Results: What astronomical conditions allow for human survival? Why? (Create a revised list below based on what you learned from the Astronomy Training Module.)

6. Conclusions: Compare and contrast your predictions and results. How did conducting research change your original ideas?

Creating Habitable Conditions for Other Planets. Choose another planet in our solar system. Write a paragraph explaining what astronomical conditions would need to change in order for this planet to be habitable and why.

Astronomy Training Walkthrough

The following is an explanation of each section of Astronomy Training. It offers suggestions for how you might take a whole class through the module, if you only have one computer with the ability to project.

Welcome

- Read the introduction with students. This explains the activity students will be going through to make changes to different features of the Solar System, to observe the effects and to record these effects.

Choose Your Character

- Tell students that they will be role-playing scientists. Read with students about each character and have them choose a scientist they wish to be. Discuss why they chose that character. (Students who are in the same group can role-play the same character so all students in the class can print out badges with their names at the end).
  - Choose your characters, entering the first name of each student.
  - **Variation: If you don't want to take the time for each student to choose a character, you could have the class vote on a character to represent the whole class.**

  Note to Teacher: The names collected are used only so that they can be printed on the badge and Astro Journal at the end. NASA does not collect this information.

What do Humans Need to Survive?

- Have students vote on their predictions, and enter these. Emphasize that in science, scientists begin with a good scientific guess. Students are not expected to know the information at this point, but are just predicting.
  Note to Teacher: At the end, students will be able to enter their conclusions and see a comparison of their predictions with other scientists' findings to receive feedback on what they have learned.

Demo

- Read over the training directions with the class and go through the tutorial. Ask students if they think the "Yellow Star" allows Earth to remain habitable or not and why or why not.

Activity

- Click "Star Type."
- Click "Yellow Star."
- Ask students what they predict will happen to Earth.
- Click "Play" to see the effect on Earth.
  Note to Teacher: "Play" can be clicked multiple times to see the effect again.

- Ask students to describe what happened to Earth and why.

- Have students record their observations in their copy of the Astro Journal under Data.

- Call on individuals to share what they wrote and have them type their observations in the Astro Journal on the computer. Ask students if they think a "Yellow Star" allows Earth to be habitable or not and why or why not.

- Record a good example of the kinds of observations you expect from students such as: "The Earth remained habitable."

- Click "Enter" to see another scientist's observation. Stress to students that they don't need to type the exact same thing, but should have the same general idea.
  Note to Teacher: Students can change their answer after they click "Enter." However, their original answers will be printed in their Astro Journal so that you can see if they are making good, initial observations.

- Point out to students that when they have completed an observation, that factor turns purple. They must complete all observations in all four major sections before they can advance to the Astro Challenge section.

- Click "Red Star."

- Click "Play."

- Ask students to give a detailed observation such as:"The Earth would grow cold and would be covered with ice and snow, because the Red Star is too cold."

- Explain that a good scientific observation is detailed and describes what is observed.

- Tell students that since they will be able to use their notes when they take the Astro Challenge, they should take thorough notes.

Completion of Activity

- Continue through each "Star Type," "Jupiter's Orbit," "Earth's Mass" and "Earth's Orbit."

- Have the class record their observations in their Astro Journals and then have individuals take turns typing in their observations in the computer.

- Have students record in Astro Journals the results of the changes they observed which resulted in a habitable Earth.

- After all observations have been completed, click "Submit" and take the Astro Challenge as a class.

- Encourage students to go back to the relevant sections and look at their notes in the Data collection chart (located in the Astro Journal section) to help answer the questions.

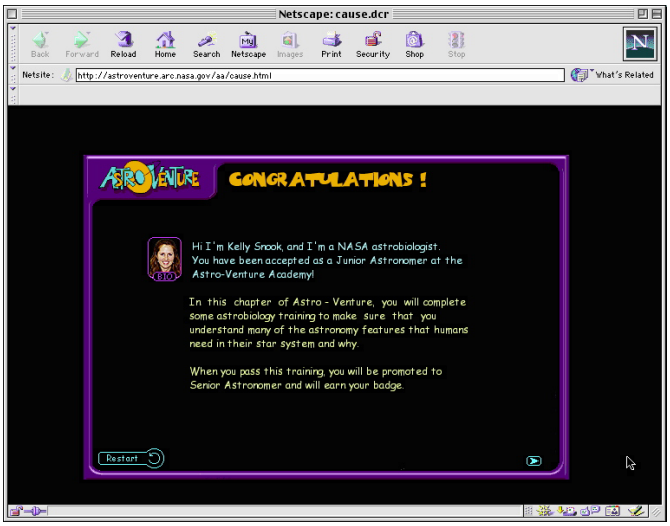
- Have students vote on the answers.

Conclusion

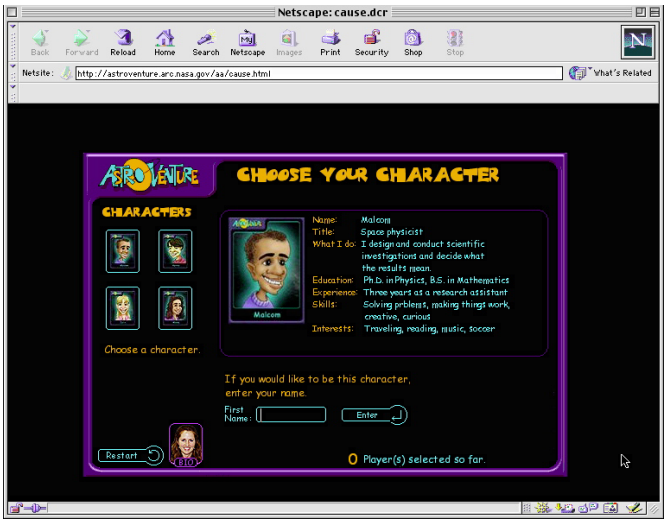
- Have students vote on the results that they found. Discuss how their results compare to their predictions.

- Print student badges, the class Astro Journal and trading cards, if you wish.

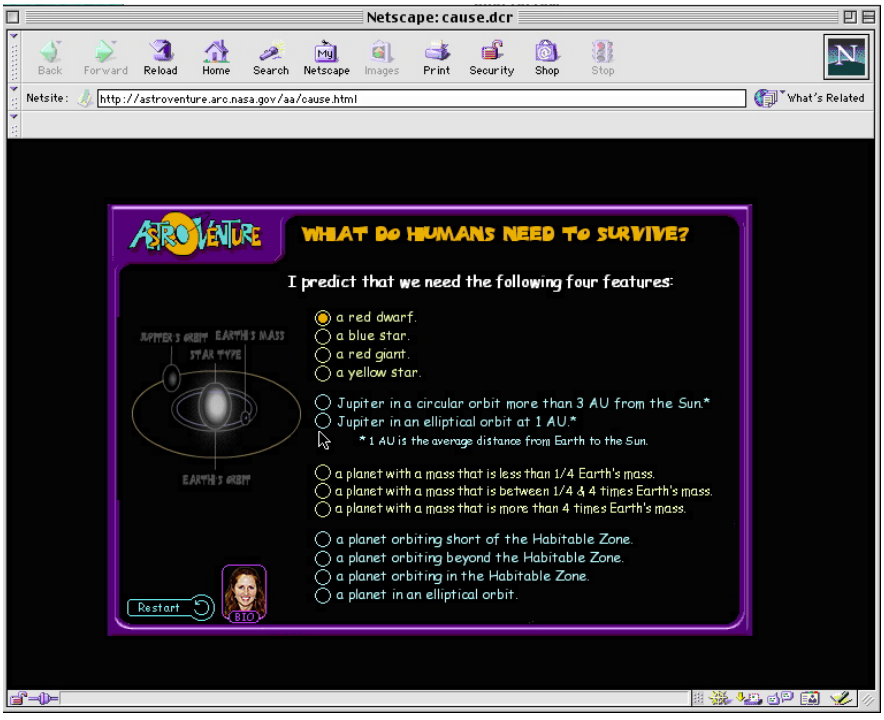
Astronomy Training Module Screen Shots



1. Congratulations!



2. Choose Your Character



3. What Do Human Need to Survive? (Prediction)

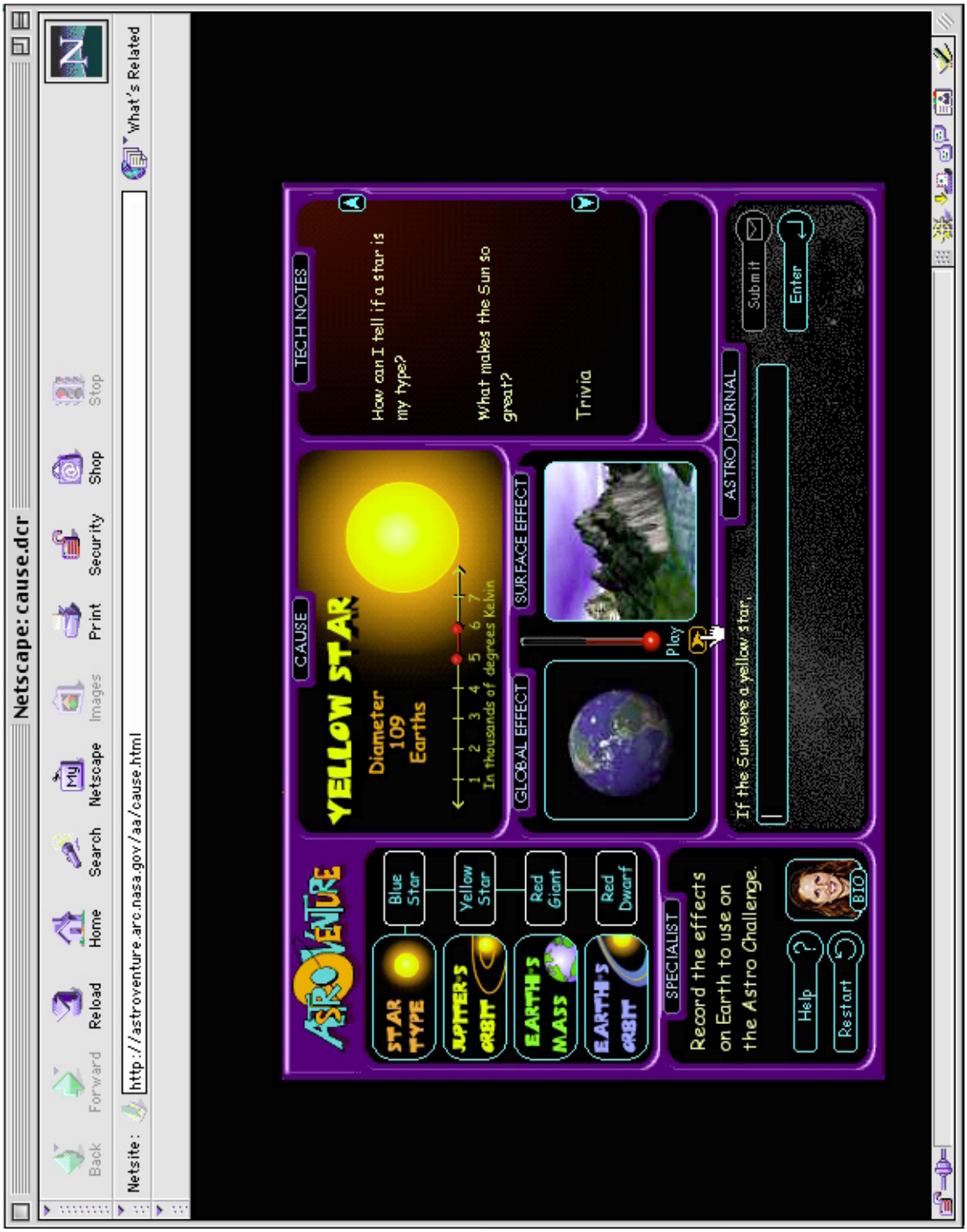
Astronomy Training Module Screen Shots

4A. Select a feature such as "Star Type" (left menu)

Astronomy Training Module Screen Shots

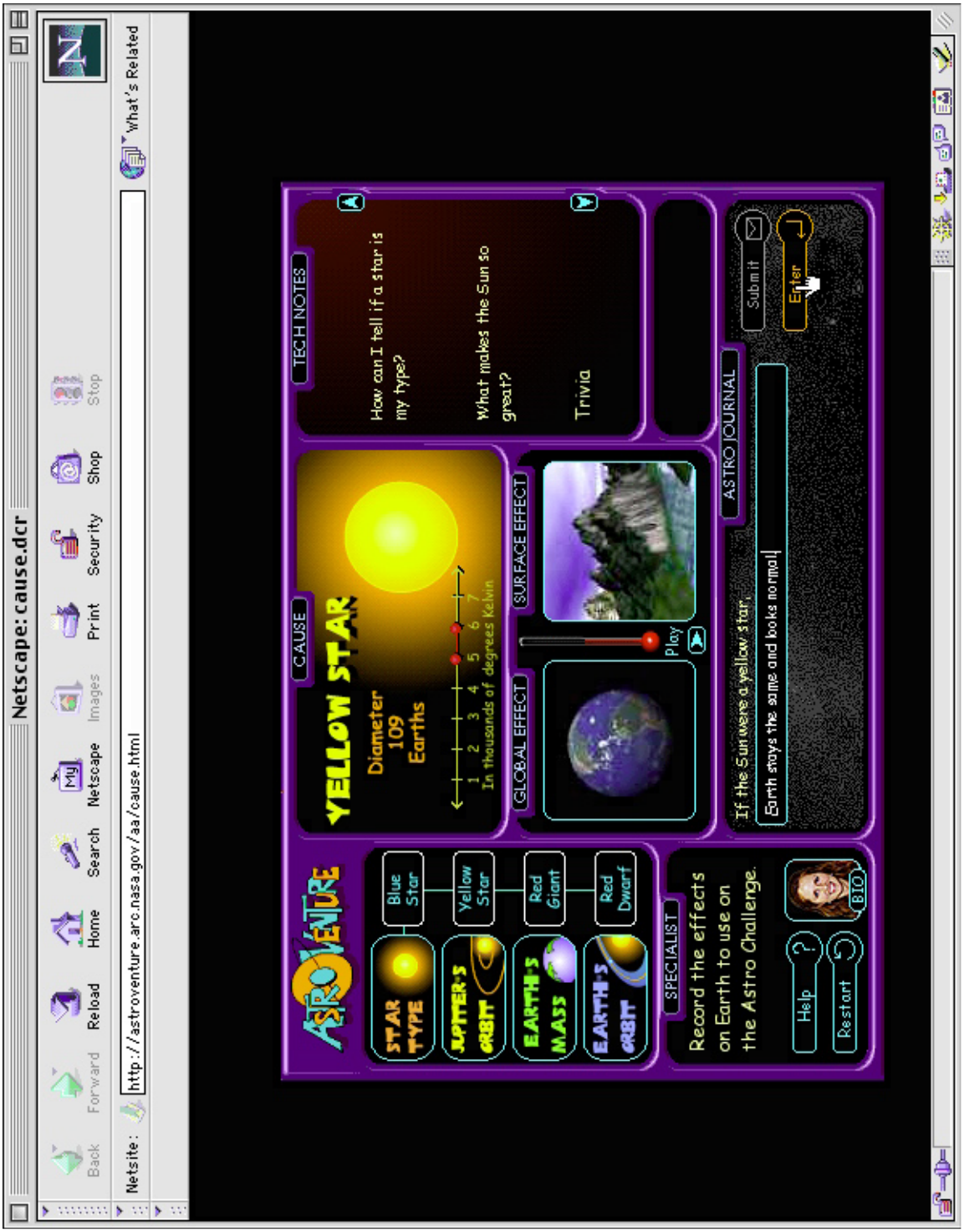
4B. Select a subtopic such as "Yellow Star" to cause a change to our Solar System

Astronomy Training Module Screen Shots



4C. Click "Play" to see the effect on Earth

Astronomy Training Module Screen Shots



4D. Record what you observe in your Astro Journal

Astronomy Training Module Screen Shots

4E. Look in your Tech Notes for background information and a glossary

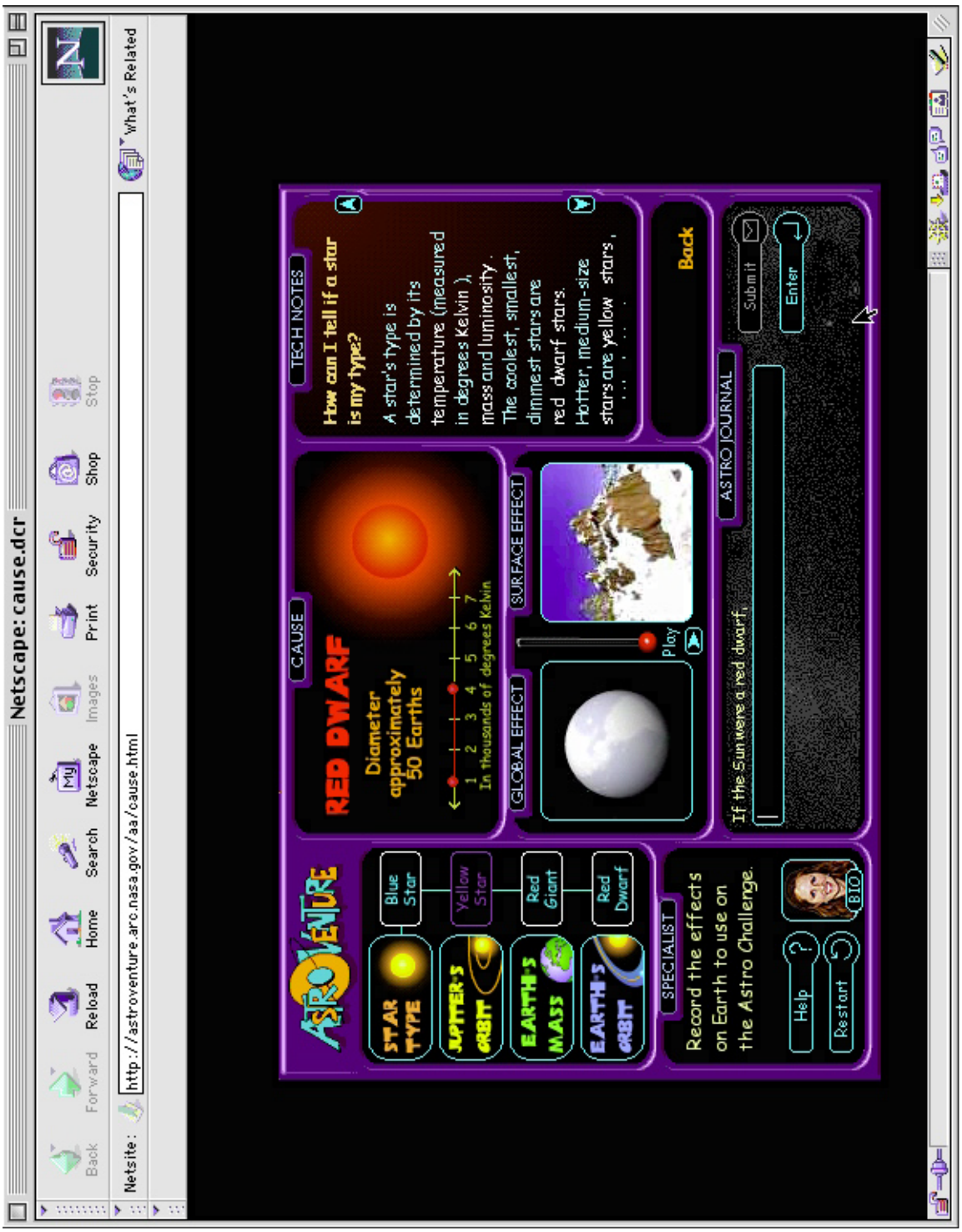
Astronomy Training Module Screen Shots

4F. Roll over highlighted words in the Tech Notes for glossary definitions

Astronomy Training Module Screen Shots

4G. The specialist will give you directions, feedback and help.

Astronomy Training Module Screen Shots

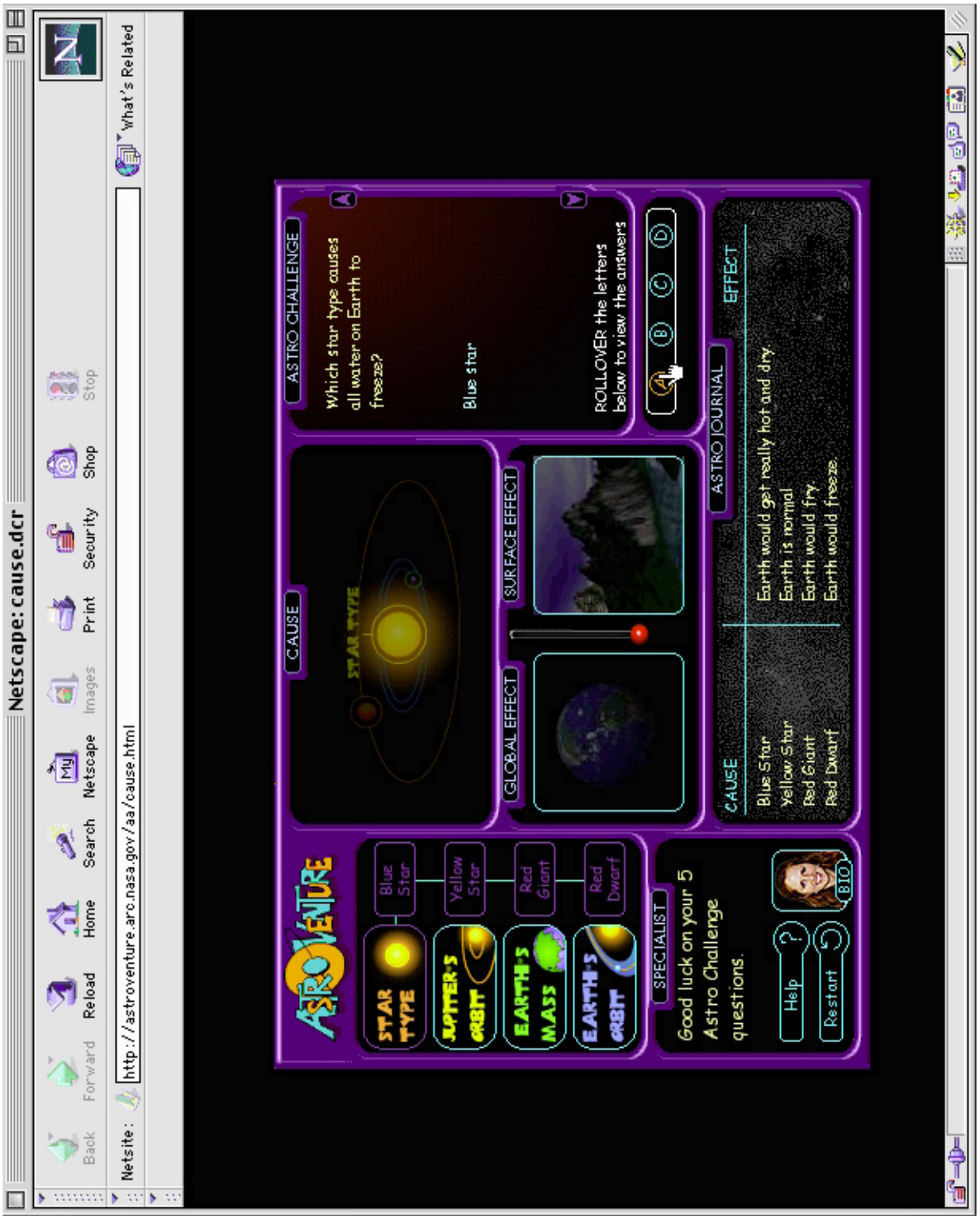


4H. Continue using steps 4A-4G for all other features and subtopics and record observations.

Astronomy Training Module Screen Shots

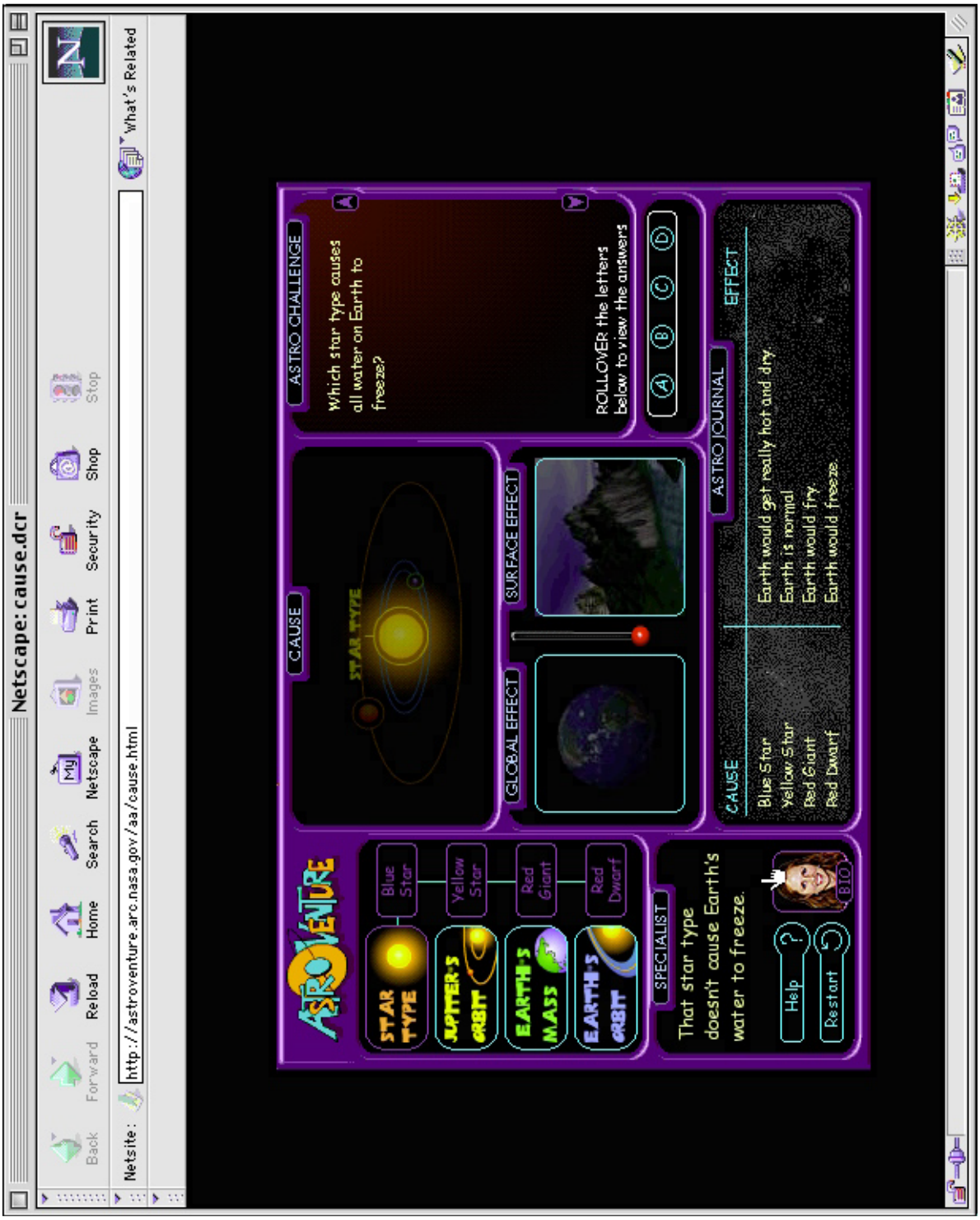
4I. When you have completed all of your observations, click the Submit button to take your Astro Challenge and earn your badge.

Astronomy Training Module Screen Shots



5. Roll over the letters to view the answers in your Astro Challenge.

Astronomy Training Module Screen Shots



6. Click above the Specialist's picture for hints to help you with your Astro Challenge.

Planetary Comparison Chart

Planet	Atmo-sphere	Mass Earth = 1	Diameter *(Radius)* (km)	Density gm/ m^3	Liquid Water	Average Temperature	Force of Gravity Earth = 1	Atmospheric Mass (kg)
Mercury	very little: argon, neon and helium	0.06	4,878 *(2,439)*	5,430	too hot for surface water	day: 350°C/662° F night -170°C/ -274°F	0.38	2.03×10^{8}
Venus	carbon dioxide	0.82	12,104 *(6,052)*	5,250	too hot for surface water	465°C/869°F	0.90	1.41×10^{21}
Earth	nitrogen, oxygen	1.00	12,755 *(6,378)*	5,520	liquid water on the surface	15°C/59°F	1.00	5.33×10^{18}
Moon	none	0.01	3,476 *(1,738)*	3,300	no liquid water	sunlit side: 134°C/ 273°F dark side: -153°C/-243°F	0.17	0
Mars	carbon dioxide	0.11	6,790 *(3,395)*	3,940	Mars may have once had surface water, but doesn't now. Ice has been detected at the North Pole.	-23°C/-9.4°F	0.39	3.09×10^{16}
Jupiter	hydrogen, helium	318	142,796 *(71,398)*	1,314	some water vapor and ice crystals in the atmosphere	-150°C/-238°F	2.53	2.6×10^{22}
Saturn	hydrogen, helium	95	120,660 *(60,330)*	690	some water vapor and ice crystals in the atmosphere	-180°C/-292°F	1.06	4.4×10^{22}
Uranus	hydrogen, helium	15	51,118 *(25,559)*	1,290	some water vapor and ice crystals in the atmosphere	-221°C/-391°F	0.93	7.8×10^{21}
Neptune	hydrogen, helium	17	49,528 *(24,764)*	1,640	some water vapor and ice crystals in the atmosphere	-235°C/-391°F	1.18	7.4×10^{21}
Pluto	methane	0.002	2,300 approx. *(1,150)*	2,030	Any water is frozen as ice.	-220°C/-364°F	0.07	variable

Astro Journal

Embarking on an Astronomy Astro-Venture!

By:_____ **(your name)**

Astro Journal

Scientific Question:

Hypothesis/Prediction: What do you predict and why?

Materials: What materials will you use to investigate?

Procedure: List the steps you will take to investigate.

Step 1:

Step 2:

Step 3:

Step 4:

Step 5:

Name:

Data Collection: Record and display your data in a chart, table, picture or graph.

Results: Summarize what your data mean.

Conclusions: Compare and contrast your hypothesis and results. How did testing your hypothesis/prediction change your original ideas?

Scientific Inquiry Evaluation Rubric For Evaluating Astro Journal Entries

Component	Expectations
Hypothesis/ Prediction	• Clearly stated • Specific enough to be testable/observable and give a meaningful result • Has basis in solid information or observations and a logical reasoning process
Materials, Procedures, and Data	• Clearly stated • Complete • Accurate and tied directly to hypothesis and scientific question
Results	• Clearly stated • Refers directly to Scientific Question and data • Draws a reasonable conclusion from that data
Conclusions	• Clearly stated • States how hypothesis/prediction was confirmed and/or altered • Refers directly to findings, observations, and/or data to explain why thoughts were changed.

Scores:
4: Expectations Exceeded
3: Expectations Met
2: Expectations Not Quite Met
1: Expectations Not Met